Rotary quern and millstone roughouts beyond their quarries

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Abstract: Groups of unfinished quern and millstones (roughouts) have been recovered in Western Europe in the sea, in rivers and along ancient roads. They have also been unearthed during archaeological excavations of cities and rural sites. These different assemblages share similarities: the grinding surfaces are not finished, the eyes are rarely pierced and the handle holes are not cut. These groups evidence a segmentation of the operational sequence of production in Antiquity, from block extraction to their sale, with the transport of unfinished products and final shaping taking place in workshops beyond the quarry near their place of use. This model differs from that in the Middle Ages where millstones were transported in a finished form.

Keywords: querns, millstones, roughouts, production, transport quarries, fashioning workshops, operational sequence

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Introduction

The discovery of cylindrical stone roughouts on sites dating to the end of the Iron Age, the Roman period and the Early Middle Ages, is generally indicative of quern or millstone production. This is, in particular, the case of the Roman rural complex of Châbles (Fribourg, Switzerland), where a large number of discarded roughouts were discovered in the backfill of a quern quarry and in secondary position in an adjacent road (Anderson *et al.* 2003) (Fig. 1). Other unfinished querns are recorded in the nearby Roman rural settlement of Bussy, Prés-de-Fond and elsewhere in western Switzerland at the Roman capital of Avenches-*Aventicum* (Anderson *et al.* 2003, 54; Castella and Anderson 2004: 125) and in settlements around Lausanne (Anderson *et al.* 1999, footnote 30). These unfinished products most likely originate in the quarry district of the Haut Broye represented by the Roman quern workings at Châbles and Chavannes-le-Chêne (Anderson *et al.* 2003). Similar Roman roughouts are also known in central Switzerland in the Canton of Aargau at Lenzburg and Zurzach, and at the military camp of Vindonissa (Anderson *et al.* 1999: footnote 30), sites near the quern quarry of Würenlos excavated in the 1930s (Doswald 1993; 1994).

Analogous finds are reported in Roman settlements in southern France. Examples are an unfinished granite *meta* (lower stone) unearthed at Mazières-en-Mauge (Boyer and Buchsenschutz 2000: 177), a *meta* with a roughly carved grinding surface and a slightly pecked eye, a *catillus* (upper stone) with roughly carved edges at Argentomagus (Mansion 1994). Other roughouts are recorded in the Greek city of Agde (Hérault) linked to volcanic quern quarry (Garcia 1995: 27). At

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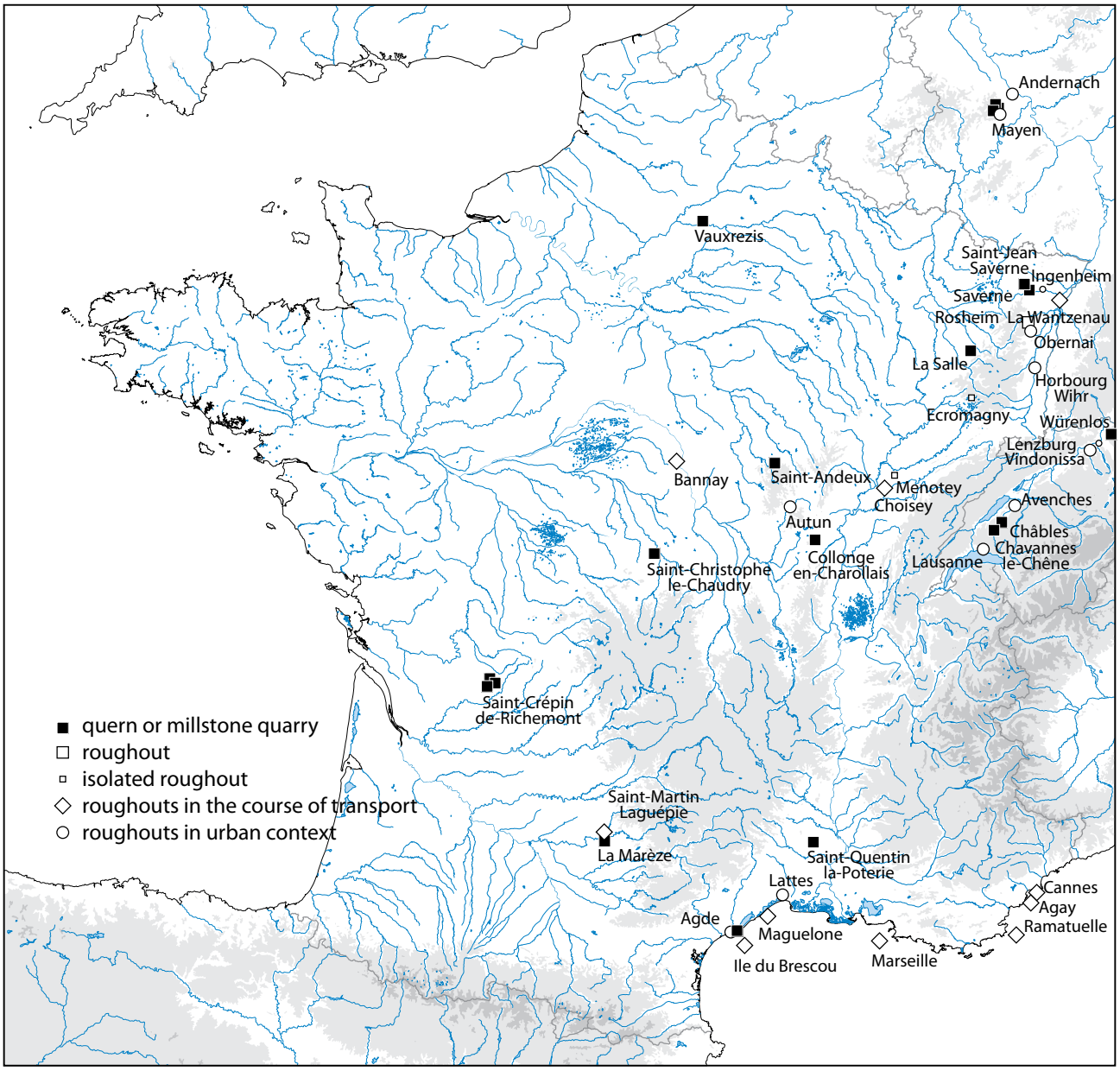

Fig. 1: Map indicating the sites cited in the text linked to quen and millstone extraction and fashioning (drawing: L Jaccottey, INRAP).

Lattes there is also a *meta* roughout and traces of quern fashioning debris in an urban workshop dating to the 4th or possibly the 3rd century BC (Py 1992: 220)[1].

Discoveries of quern roughouts, beyond quarry contexts, are also recorded in eastern France. All of these artefacts raise the question of the nature of unfinished products at sites that offer no evidence of millstone extraction. They lead to speculation that the fashioning of querns and millstones did not take place exclusively in or around the quarries, but that this sequence of operation included an additional phase carried out beyond the quarry itself for either all or part of the production.

This notion was advanced in the publication of the Châbles quern quarry where, among the hundreds of roughouts, there are no completely finished querns (Anderson *et al.* 2003: 272). The focus of the current study is therefore on the unfinished rotary querns and millstones found outside of quarry contexts, artefacts that are rarely cited in archaeological reports.

The study in detail of these products begins by establishing their degree of completion so as to compare them with others found in quarries where the operational sequence of manufacture has been established. The study of their contexts not only assists in their dating, but throws light on the function of the sites, often settlements, where they were unearthed.

1. The recent visit to the Museum of Châtillon-sur-Seine discarded a stone from the site of Verthault previously identified as a millstone roughout (Boyer and Jouin 2001: 30).

After presenting the state of research regarding the main quarry sites, this study will turn its focus on the roughouts (at times called blanks) themselves found beyond quarry contexts. The study explores the question of their state of completion and compares them with examples from quarries, and attempts to pinpoint their position in the operational sequence of quern and millstone production.

Quern and millstone roughouts in quarries

There are currently only a few millstone quarries offering detailed information as to their roughouts. Certain sites, either old excavations that did not record their roughouts or workings with a modest number, were not integrated into this study. Examples are the early 20th century excavations in Switzerland of Würenlos (AG) and Chavannes-le-Chêne (VD) (Anderson *et al.* 2003). Other workings inferred from only a single roughout are known in the Serre Massif (Jura) (Jaccottey and Milleville 2008) and at Ecromagny (Haute-Saône) (Jaccottey, unpublished), as well as the outcrops between Hirson (Aisne, F) and Macquenoise (B) (Picavet *et al.* 2018) along the border between France and Belgium.

The quarries of Saverne and Saint-Jean-Saverne (Bas-Rhin) (Jodry 2011; Meyer and Nüsslein 2014) were also discarded. Although a few roughouts from these workings offer data regarding millstone extraction and fashioning techniques, they do not shed light on their operational sequences.

Otherwise, a great number of roughouts were collected at other quarries at Agde (Hérault) (Garcia 1995), Saint-Quentin-la-Poterie (Gard) (Longepierre 2013), Mareze (Tarn-et-Garonne) (Jodry 1997; Servelle 2011), Saint-Crépin-de-Richemont (Dordogne) (Guillin 2011), Saint-Christophe-le-Chaudry (Cher) (Gaultier 2011) and Vauxrezis (Aisne) (Robert and Landreat 2005). These artefacts are also not taken into account in the current analysis as they have not been studied in detail.

The quarry of Châbles (Fribourg, Switzerland)

This excavation brought to light 272 *grès coquillier* (shell-rich sandstone) quern roughouts dated between the end of the 1st century and early 2nd century AD (Anderson *et al.* 2003: 57, fig. 63). The roughouts were recovered in the backfill of the quarry itself (33), around a house and smithy (4), and in a segment of a road 6 m wide passing a few metres from the quarry (235). The discarded querns in the road (300 m excavated) were either incorporated in its original foundation or in secondary position as repair. Those in the foundation, especially in the eastern sector about 200 m from the quarry, suggest the existence of another older quarry, preceding the road's construction.

The roughouts in the backfill of the quarry, due to favourable conditions of preservation, conserved their original tool marks in the form of wide diagonal bands on their edges corresponding to the cutting of a circular trench around them with a single-pointed pick. They also bear thin lines produced during the regularisation of their form by multiple pecks with a pointed chisel (26 of 33 cases). The preservation of the roughouts in the road, by contrast, is very different as their surfaces were altered by water infiltration (erasing the finer tool marks). Among the finds with signs of surface regularisation, only one *catillus* has traces of the cutting of the eye and there are no indications of lateral handle socket cuttings. In fact, the only finished *catillus* at the site was found the smithy. But as it is of granite, it is not hewn from the quarry but probably fashioned from a small erratic boulder. Furthermore, none of the *metae* roughouts reveal traces of the carving of the eye. There is therefore no evidence that the cylindrical querns extracted directly with a pick from bedrock at Châbles were finished at the quarry itself. The authors suggest they were possibly finished and marketed in a workshop at *Aventicum*, the capital of Roman Switzerland, about 15 km away (Anderson *et al.* 2003, 272).

The quarries of La Salle «Les Fossottes» (Vosges)

These workings produced saddle querns and rotary querns at the end of the Early Iron Age and in the Roman Era. The site was the object in recent years of detailed field surveys as well as a systematic study of its roughouts (Farget 2006; Farget and Fronteau 2011). The workings comprise two rhyolite outcrops to each side of the Valdange stream. The first, Grandes Fossottes, is on a hillock to the west whereas the second, Petites Fossottes, is to the east. Together they yielded a total of 63 roughouts. Twelve, devoid of context, are either in the Museum of Saint-Dié or in private gardens near the outcrops. Another is in a garden in the village outside of the area. Thirty-one are in three different properties in the area of Petites Fossottes. Sixteen are in another property at the foot of the Grandes Fossottes. Finally a single piece bearing chipping scars on its faces was unearthed in a trial trench at Grandes Fossottes (V. Farget, unpublished).

All the roughouts from Petites Fossottes show signs of the regularisation of their surfaces. The piercing of the eye of three of them was either in progress or completed. Two metae have blind eyes. The surfaces of the roughouts near Grandes Fossottes were also regularised and the eye of a *meta* was in the process of being pierced.

The quarry of Le Portus, Collonge-en-Charollais (Saône-et-Loire)

This site corresponds to a series of workings along a Triassic sandstone outcrop near a small Roman settlement. A surface survey identified 27 roughouts. Their study, combined with the analysis of the chipping flakes at both the quarries and in certain sectors of the nearby Roman town, suggests

that their first phase of fashioning took place near the quarries. The regularisation of their surfaces, however, was clearly carried out in sectors of the settlement (Jaccottey *et al.* 2011). Three were abandoned during an earlier stage of fashioning and 24 during the later phase of surface regularisation. While four *metae* and three *catilli* show evidence of the piercing or of the process of piercing of the eye, none bear evidence of the cutting of the lateral handle socket.

The quarries of Bois de Joux at Saint-Andeux (Côte-d'Or)

The vaugnerite quarries of Saint-Andeux produced both Celtic and Roman rotary querns and a few larger millstones. Surface surveys indicate a division into two sectors (Jaccottey *et al.,* this volume). The site comprises 102 roughouts: 42 from the northern sector and 29 from the southern sector in heart of a wooded area. The original context of the remaining displaced roughouts is unknown. The study of the distribution of the roughouts of one of the two sectors indicates that those in direct quarry context were only roughly chipped, while those bearing traces of regularisation were grouped in small peripheral areas, probably workshops. Although three *catilli* bear eye cuttings, none show indications of lateral handle socket cuttings. The *metae* eyes are also not pierced.

The quarry of Purpurkopf-Rosheim (Bas-Rhin)

Purpurkopf is hillock surrounded with what is interpreted as an oval defensive wall. Downhill are a number of natural or artificial "taluses" formed by detached blocks bearing traces of millstone workings indicative of what appears to be a long tradition of quern and millstone making. The morphology of certain cases suggest a dating from the Middle Ages. More recent surveys (Holderbach 2013; Jodry and Holderbach 2017) identified eight blocks bearing extraction marks (Fig. 2) and five rotary quern roughouts in different phases of the production process, from simple rough chipping to finishing (although none has a final surface regularisation or eye cutting). These newer finds appear to extend the workings to an earlier period, possibly the Late Iron Age or the outset of the Roman Era.

The analysis so far has focused on roughouts from sites dated to the Late Iron Age (La Salle, Rosheim and Saint-Andeux) and Antiquity (Châbles, Collonge-en-Charollais, La Salle, Rosheim and Saint-Andeux). Rotary querns and a few millstones at these different workings were produced either in the form of cylinders hewn directly from bedrock such as at Châbles (type MQ-2a, Anderson 2014; 2016) or as blocks either collected on the surface (MQ-1a) or detached from rock faces (MQ-2b) (e.g. Collonge-en-Charollais, La Salle, Rosheim and

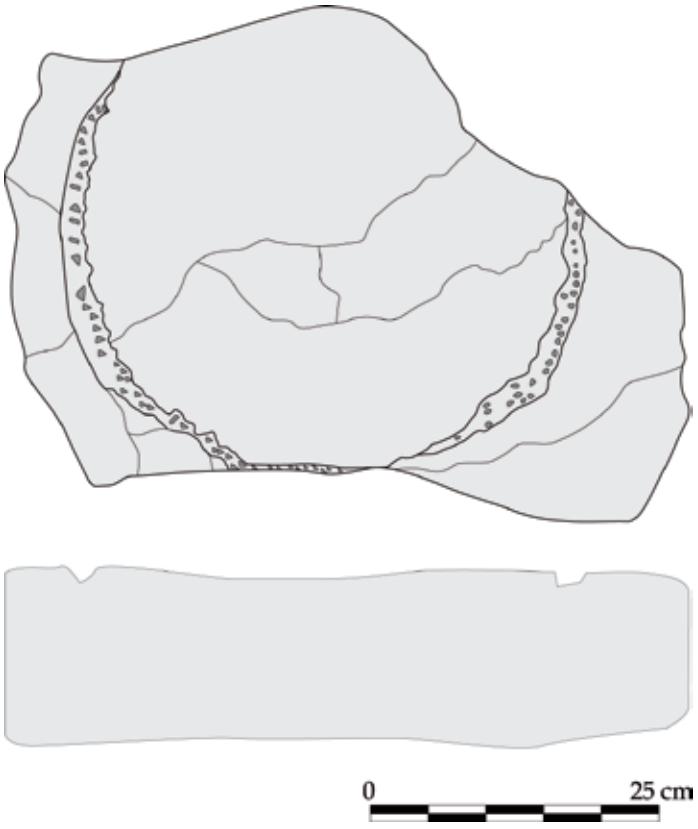

Fig. 2: Detached block at the site of Purpurkopf-Rosheim (Bas Rhin) in the process of being fashioned into a rotary quern (F. Jodry, INRAP).

Saint-Andeux). The edges and the upper and lower surfaces were more or less coarsely carved. There are indications of the fashioning of the rims along the edges, hoppers and eyes of *catilli* at all the sites except Rosheim. Moreover, *metae* eyes were carved at Collonge-en-Charollais and La Salle, but not at Châbles and Saint-Andeux. In addition, no site reveals evidence of the cutting of lateral handle holes.

Roughouts at sites beyond quarries

Obernai (Bas-Rhin)

The archaeological excavation of the Late La Tène settlement of Obernai in 2013 by C. Féliu uncovered at least five rotary quern roughouts in various stages of fashioning (Féliu *et al*. 2017; Féliu and Jodry 2017) in structures near a settlement and a ditch enclosure dating from the 1st century BC. The lot comprised three coarse sandstones (2 fragmented) and two rhyolites. The only whole piece is a disc-shaped *Bundsandstein* blank with an unfinished edge marked by alternating patches of regular and irregular carving (Fig. 3). A lateral chipping scar indicates it broke during fashioning.

This irregular cylinder has dimensions approaching that of finished querns (diameter: 35 cm; thickness: 16 cm). One surface bears a central hollow that could be the outset of either a hopper or a grinding surface. The opposite surface reveals a large, oblique chipping scar indicating the desire to obtain a flat surface. Its edge and rim are covered with tool marks. The same can be said for both sandstone roughouts, one of which bears pointed chisel marks along its edges. Both measure 38 cm in diameter and 15 cm in thickness. A few chipping flakes unearthed in nearby structures also bear witness to the existence of a quern fashioning workshop in the area.

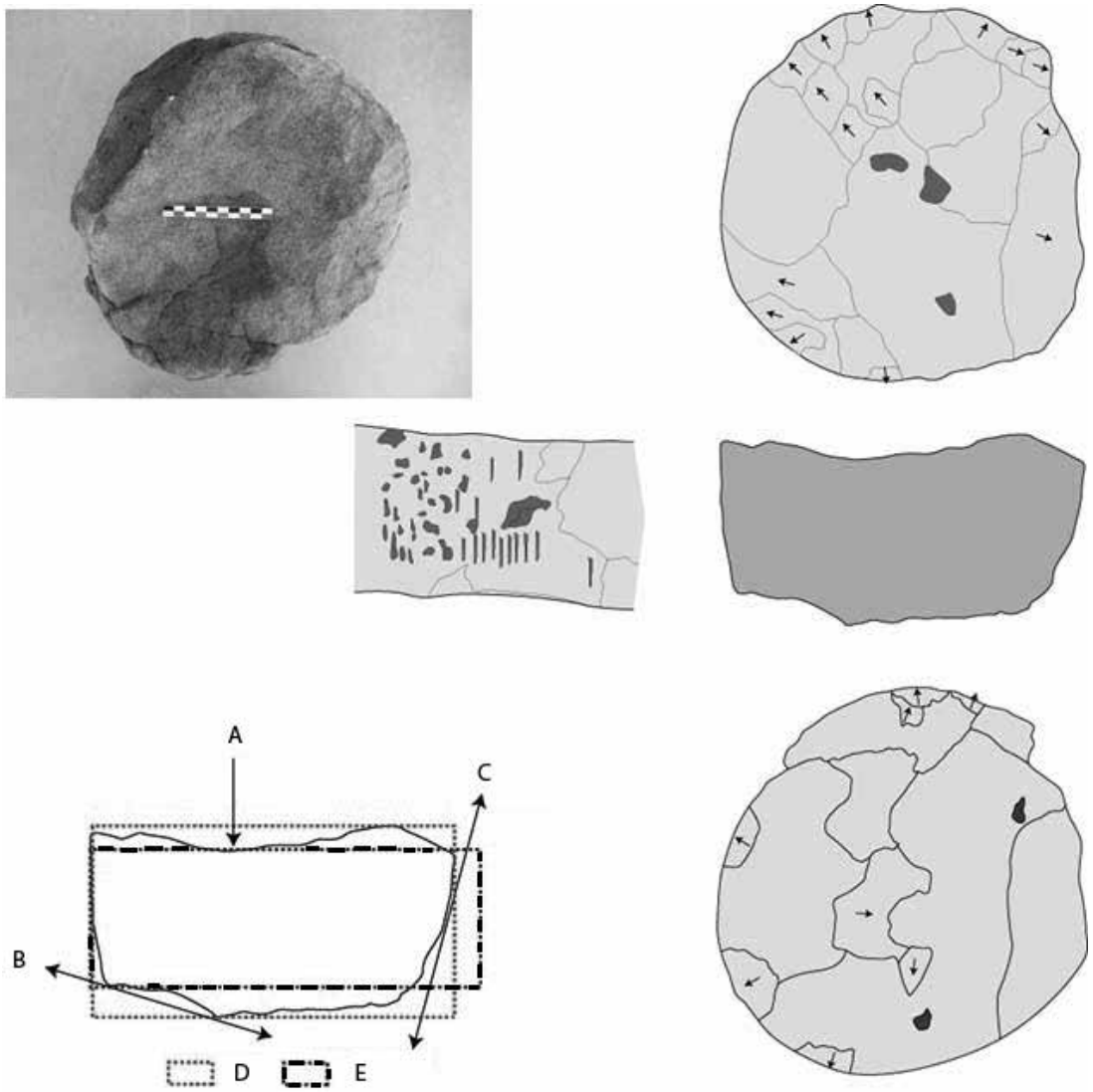

Fig. 3: Views of a discarded Late La Tène rotary quern sandstone roughout from the settlement of Obernai (Bas Rhin). a) concavity corresponding to the carving of the hopper or grinding surface; b) scar of a large chipping along its base; c) break; d) estimated maximum dimensions of the block; e) standard dimension of a Late La Tène upper stone (drawing: Florent Jodry, INRAP).

Fig. 4: Unfinished rhyolite rotary quern pair discovered at the settlement of Obernai (Bas Rhin) (photo: F. Jodry, INRAP).

The excavation also unearthed an unfinished rhyolite rotary quern pair (Fig. 4) in the backfill of a Late La Tène structure. This type of mill, elegantly fashioned despite its irregular morphology, is common to this chronology. Its *meta* measures 34 cm in diameter and 13 cm in thickness. Its *catillus*, 15 cm thick, with a concave hopper, has edges that are slightly flared as its upper diameter (38 cm) is greater than its lower (34 cm). The cutting of the *meta* eye appears to have been abandoned just after it was begun. The circular eye of the *catillus*, in turn, is finished. As in the case of the eye of the *meta*, the cutting of the lateral handle socket, only 2 cm deep, was hardly begun. The grinding surfaces of each are equally in their initial phases.

Ingenheim «Bannenberg» (Bas-Rhin)

The roughouts identified at Obernai led to reviewing two finds unearthed in a trial trench at Ingenheim (F. Latron, INRAP) dated to the Late Iron Age. The first is a rhyolite measuring about 40 cm in diameter and 15 cm thick bearing characteristic marks of quern making by pick and pointed chisel. The second is an irregular coarse sandstone block with a rounded form. The two appear to correspond to the fashioning of detached angular blocks.

Choisey «Carrefour de Gevry» (Jura)

An assemblage of nine querns was unearthed at Choisey (Jura) during excavations carried out by F. Seara (AFAN, 1998). The querns form part of a stone feature dating from the 1st century AD set along the edge of a major Roman road (Fig. 5).

The assemblage is interpreted as an abandoned land transport cargo. The lot is made up of two fragmented *metae*, a whole *meta*, three fragmented *catilli*, a whole *catillus* and two *catilli* roughouts. The grinding surfaces of the two roughouts are roughly carved. Yet, contrary to the other querns, they bear no traces of having served for grinding (Fig. 6). The first, a *catilli* measuring 50 cm in diameter, is only partially preserved. It has a circular eye flanked by rynd cuttings (Type 2C, Robin and Boyer 2011). It is thick and its surface is roughly regularised. The second, a fragment 45 cm in diameter, is complete enough to determine no lateral driving cuttings. Its eye resembles that of the first.

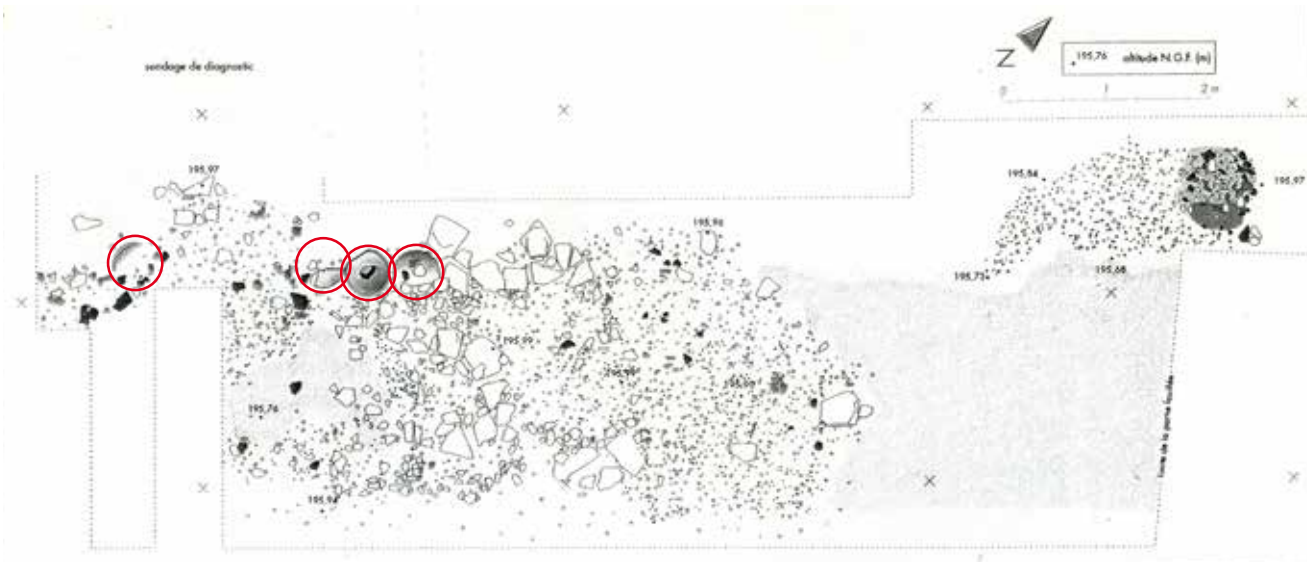

Fig. 5: Plan of a stone feature along a Roman road at Choisey (Jura). The quern assemblage comprising two roughouts is interpreted as an abandoned land transport cargo (from Seara 1998).

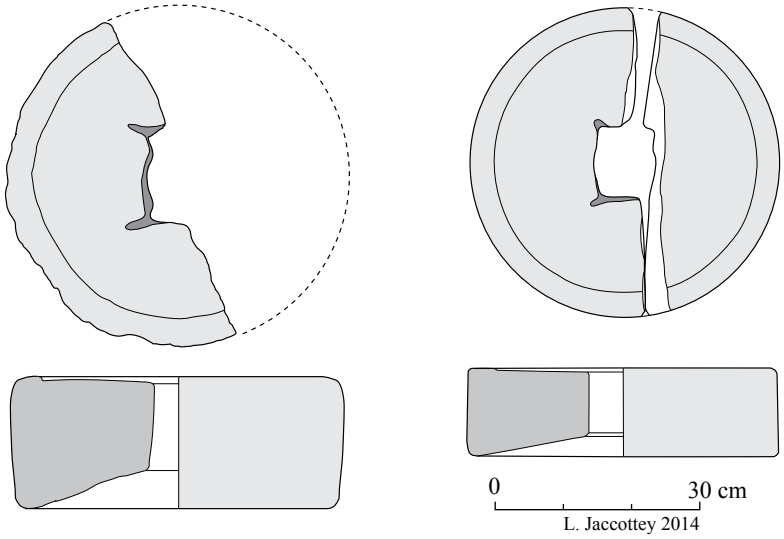

Fig. 6: Catilli from the stone feature along the Roman road at Choisey (Jura).

Fig. 7: Plans of the different chronological phases of the Roman urban site of Autun (Saône-et-Loire) with the position of the roughouts and finished millstones (drawing: S. Alix, INRAP, 2014).

Autun «Faubourg d'Arroux» (Saône-et-Loire)

The excavation directed by S. Alix (INRAP, 2010) at the "Faubourg d'Arroux" of the Roman city of Autun brought to light a workshop quarter (pottery, bone working, iron working, ...) dated between the Augustan period and the 4th century AD. The excavation (3,500 m2) yielded a total of 75 querns, including 19 roughouts (10 *metae* and 9 *catilli*) and three querns with signs of re-carving (Fig. 7). Two of the roughouts (one at the base of the stratigraphic layer) date to between 40 and 70 AD. The others were re-used in later phases.

The comparison of the diameter of the roughouts with that of other finished querns from the same chronological framework reveals that their diameter exceeds that of finished querns by between 2 and 12 cm, a clear indication that their edges were not completely regularised. This is confirmed by the tool marks visible on almost half of the lot. The finishing phase carried out here consisted of regularising the edges, and possibly tracing the contour of the final diameter with a pointed chisel, a technique most often undertaken by regularising the upper and lower rims along the edges with a chisel along a band between 3.5 to 4 cm wide.

The central area of six of the ten *metae* roughouts was sufficiently preserved to determine whether their eye was pierced or not. Two bear small blind eyes (Fig. 8: 25,71), a feature that is absent from the others (Fig. 8, 57-58). The two querns have eyes that are in an advanced phase of cutting. It is therefore possible to deduce that the eyes of the *meta* roughouts were not pierced until after their arrival at the settlement. Moreover, one broke during this phase.

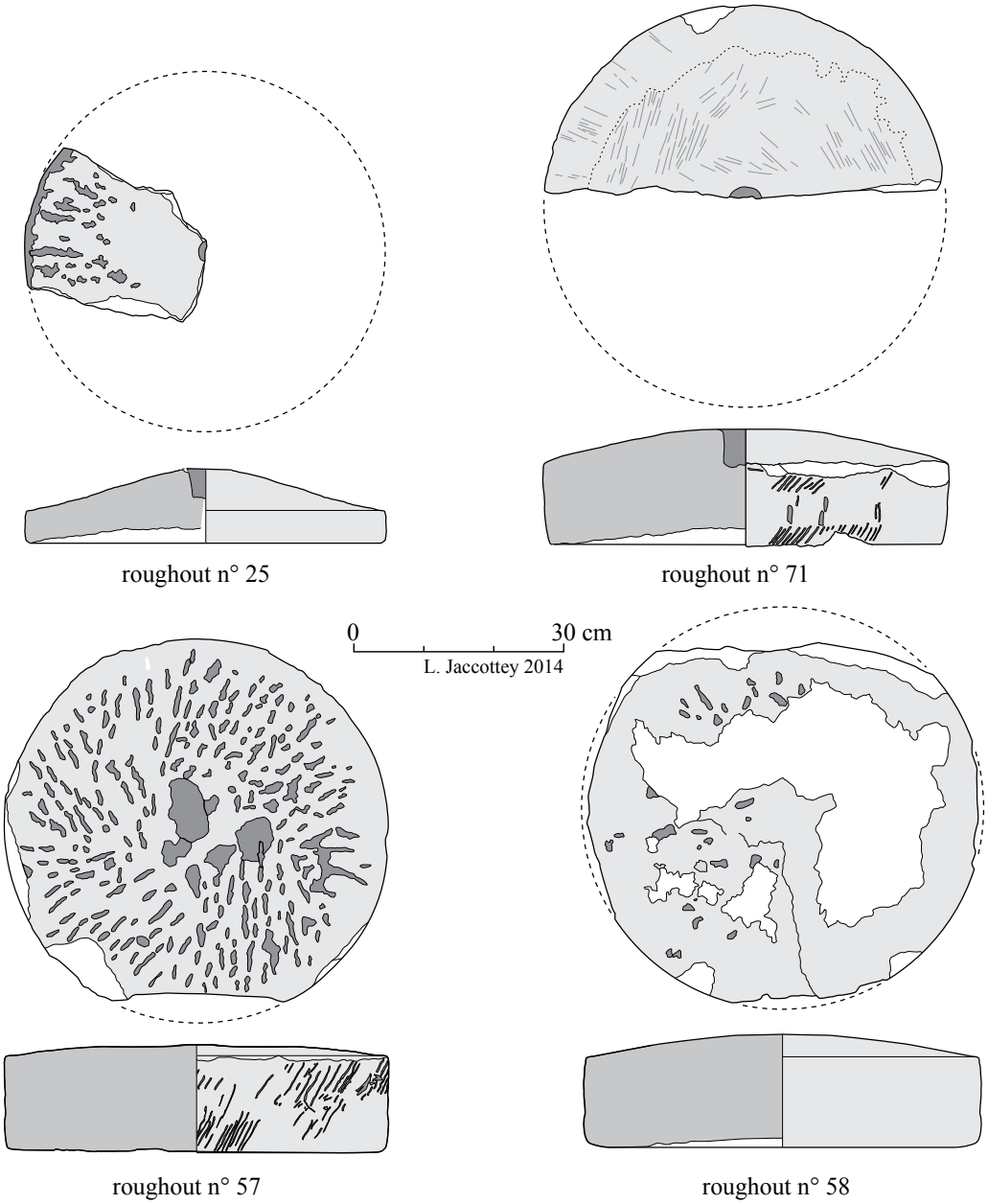

Fig. 8: Lower stone roughouts from the Roman urban site of Autun (Saône-et-Loire).

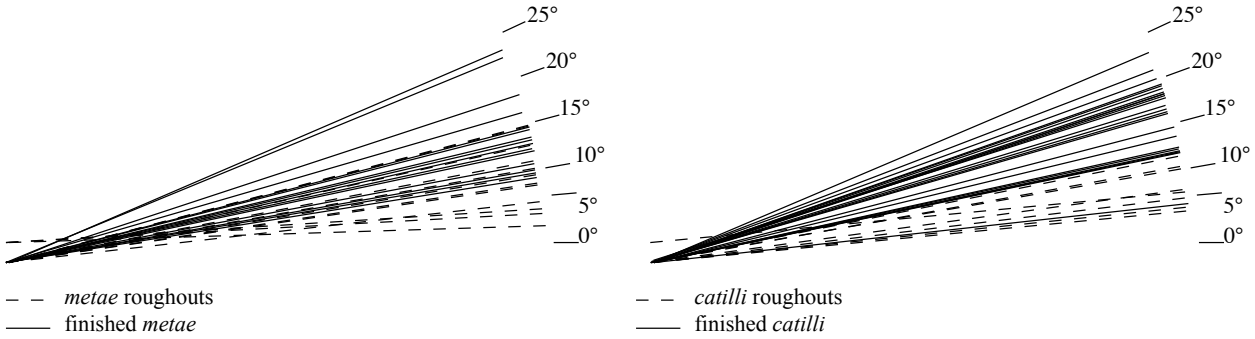

Fig. 9: Comparison of the angles of the grinding surfaces of the sandstone millstone roughouts (broken line) and sandstone finished querns (full line) at the Roman urban site of Autun (Saône-et-Loire) (L. Joccottey, INRAP).

One of the more remarkable features of these roughouts is that their grinding surface were only roughly regularised, leaving clear tool marks. The study of the angles of the grinding surfaces of the sandstone *metae* indicate that they vary between 3.1° and 14.8°, values that are much lower than those of finished *metae* (9° to 23°). The same tendency can be observed for the *catill*i (Fig. 9). The roughouts are therefore slightly conical and the carving of their grinding surface is characterised by a greater conicity.

The fact that the eyes of the *catilli* roughouts are carved indicates that this action was carried out before their transport to the workshops at Autun. Their type of eye, like that of the finished querns, depends of the type of sandstone. The future active surfaces of both the *catilli* and *metae* are roughly regularised with a pointed chisel (Fig. 10: 49, 87). The intended grinding surface angle of the *catilli* roughout is between 5.4° and 12.5°, whereas the angle of finished *catilli* is almost always between 12° and 25°. This difference is also observed among the *meta* roughouts. No lateral handle hole was observed among *catilli* roughouts, even among those that are whole (Fig. 10: 60,87).

Horbourg-Wihr (Haut-Rhin)

A trial trench at the Roman *vicus* of Horbourg-Wihr (42 Grand'rue) near the city of Colmar unearthed three quartzitic sandstone *meta* roughouts dated to the end of the 2nd century AD (Nilles 2013). The best preserved, whole with no central perforation, measured 47 cm diameter and 12 cm in width (Fig. 11). The thickness of its edge varies between 9.5 and 10.5 cm. The two others are fragmented and measure respectively 48 and 45 cm in diameter and 12 to 15 cm in thickness. Their circular eyes are 4 cm in diameter and 4 to 5 cm deep. Although these querns were unearthed in secondary position in a layer of demolition, it is very likely they were associated with a nearby workshop because their grinding surfaces were in the process of regularisation (mainly along their centre and edges (Fig. 11: a-b). The distal area of the whole lower stone bears signs of grinding surface adjustment evidenced by the carving of a sort of flat indentation about 2-3 cm wide along its edge that served as a guide for the final grinding surface. This indicates that the final phase of quern making was carried out from the quern's edges toward its centre. The central eye was only carved after attaining the desired angle of the grinding surface. The area around the eye therefore remained coarse and the outer edges were only roughly pecked.

Based on these new informations, we reinterpreted the nature of a lower stone fragment (RLT-1243-1) from another excavation by C. Féliu at the Rue de Bretagne (INRAP, site currently under study), 200 m from the zone of the workshop. This fragment only conserves its central area, impeding reconstruction of its diameter. Its eye, partially preserved, is 4.5 cm in diameter and 4.5 cm deep. On the opposite face there is a small diagonal cavity 3.5 cm in diameter and 2 cm deep. Although this second hole on the lower face could have served to fix the stone to a table, it cannot be excluded that it is the start of the total perforation of the eye. If this were the case, then this artefact is also a roughout far beyond its quarry.

La Wantzenau "Rohrwoerthfeld" (Bas-Rhin)

The remains of a Roman shipwreck were discovered in 1911 at Rohrwoerthfeld during work by at the Weigel & Roth gravel pit (Jodry 2000). The site, about 20 km north of Strasbourg, was originally published by Forrer (1911) who described the cargo as an assemblage of pottery, metal artefacts (axes, weights, coins and cauldron) and 27 volcanic millstone roughouts. The artefacts of the assemblage suggest the cargo dates to the third quarter of the 3rd century AD.

The roughouts are in the form of flat disks (0° angle) with an irregular (at times diagonal) piercing of the eye, proof they were unfinished. Their diameters range from 38 cm to 48 cm, with a relatively uniform thickness of 7.5 to 10

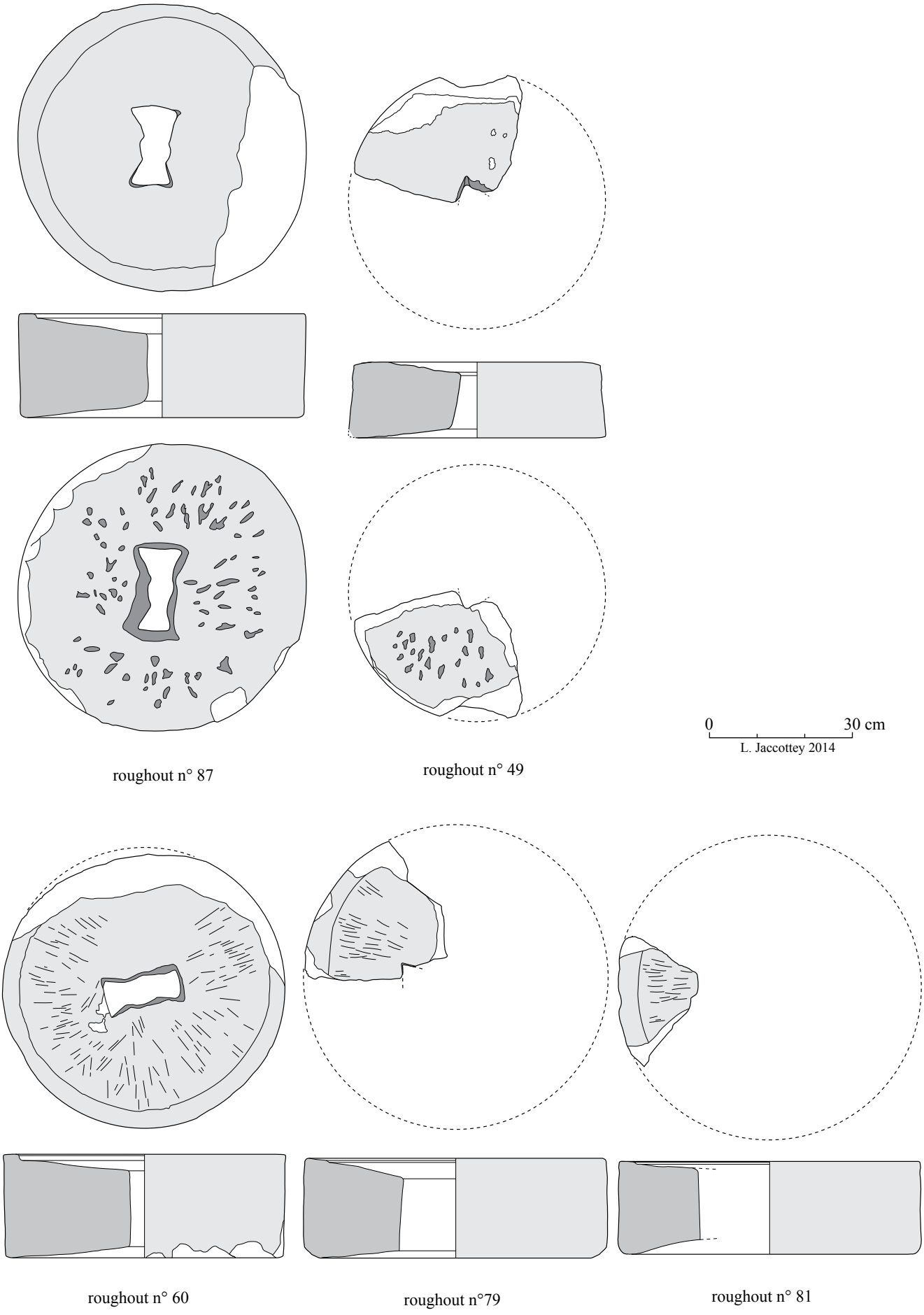

Fig. 10: Upper stone roughouts from the Roman urban site of Autun (Saône-et-Loire).

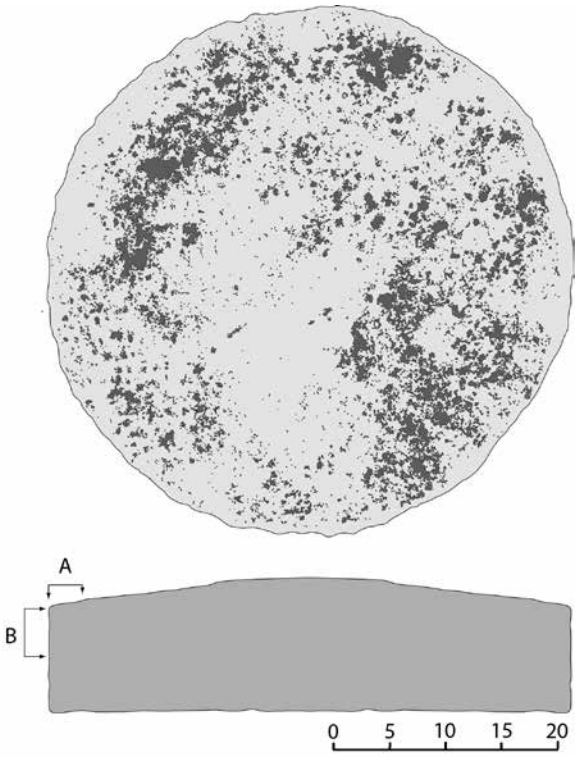

Fig. 11: Quartzitic sandstone lower stone rotary quern roughout from the site of Horbourg-Wihr (F. Jodry, INRAP).

cm. Although their surfaces, roughly carved, were observed in detail, it was not possible to distinguish which was intended for grinding. The stones also bear no trace of the carving of a hopper or rim, or any surface treatment such as dressing.

Bannay «Cours de la Loire» (Cher)

Seventeen querns were discovered in 2011 during an underwater survey (A. Dumont, DRASM) of a sand bank of the Loire River in the Municipality of Bannay (Fig. 12). The assemblage, still underwater today, comprises two alignments (L. 1: nos. 1 to 4; L. 2, nos. 17, 5 to 7 and nos. 11 to 16) (Fig. 13) and a few other isolated stones (nos. 8 to 10).

No trace of a ship was detected in the subsequent survey of 2012. The lot therefore either corresponds to the cargo of a capsised ship or, more likely, to a load of stored by the river that was swept away by a flood. In spite of the water's turbidity, the stones appear to be sedimentary. The sole recovered to date, according to A. Polinski (UMR 6566 CReAAH, Nantes), is an arkose.

The stones range in diameter from 58 to 72 cm and apparently have flat grinding surfaces, dimensions that are most commonly associated with the Middle Ages. The lot can be classified into two groups. The first ranges from 58 to 66 cm in diameter and 15 to 19 cm in thickness with a circular eye between 6 to 8 cm. The second comprises those from 69 to 72 cm in diameter, 19 to 26 cm in thickness and an eye between 8 and 11 cm.

The group with the smaller diameter could correspond to rotary handmills designed to be driven on tables from a standing position by means of a vertical rod or pole attached to the ceiling (a type known since the Early Middle Ages). Several examples characterised by a very small eye are known in central France at, for example, Saint-Florent-sur-Cher (Cher) (Robin 2013, SARAN).

The group of larger stones, in turn, could correspond to grinders destined for watermills. Similar millstones, measuring about 70 cm in

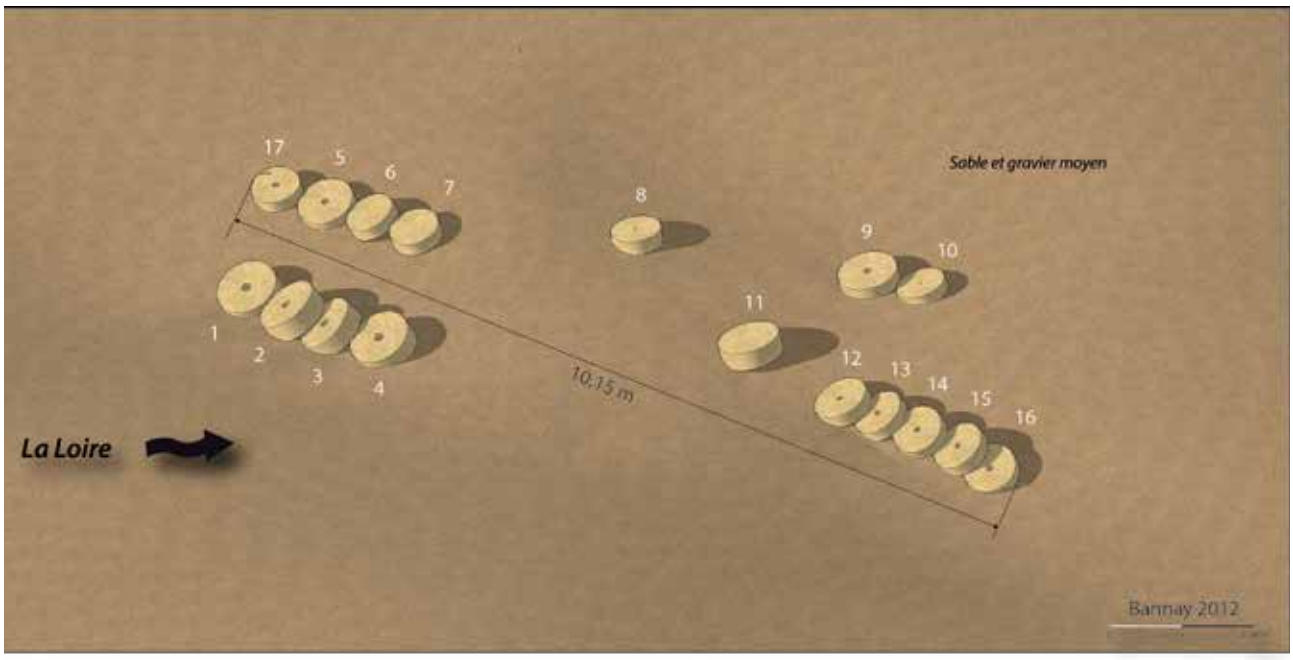

Fig. 12: 3D modeling of the alignment of medieval millstones discovered in the Loire River at Bannay (Cher) (infographics: P. Moyat, program: SketchUp). The stones come either from the capsising of a ship or the displacement of a load by floodwaters.

Fig. 13: Alignment of millstones nos. 12-16 in the Loire River at Bannay (Cher) (photo: P. Moyat).

diameter and dating from the 7th century, are known at Pratz in the French Jura (Jaccottey, currently under study). Three other hydraulic models from the 7th century were uncovered during excations at Develier-Courtételle in the Swiss Jura (Marti *et al.* 2006) and two stones measuring respectively 70 and 72 cm, dated between 840 and 969 AD, were unearthed at the watermill of Audun-le-Tich (Rohmer 1996). Others ranging between 56 and 76 cm are known in a hydraulic context at Villarnau in the eastern Pyrenees dated between the 9th and 10th centuries (Martzluff *et al.* 2008).

The stones from Bannay can therefore safely be placed in a time frame ranging between the 7th and 10th centuries. Since they are still below water, it is not possible, at least for the moment, to fully observe the state of completion of their different surfaces. Initial observations, nonetheless, suggest the perforation of the eye of certain cases (nos. 1 to 5, 9 and 12 to 17) and either the absence (nos. 6, 7 and 11) or only partial perforation of others (nos. 8 and 10).

Saint-Martin-Laguépie «Cours de l'Aveyron» (Tarn)

Another site linked to millstone fluvial trade was identified in the Municipality of Saint-Martin-Laguépie, upstream from La Wantzenau and Bannay. Field work carried out in 1997 located quern roughouts at the placename *Le Port* that were probably ready to be embarked for transport (Jodry 1997). They comprise three cylinders with dimensions compatible with Late Iron Age rotary querns. They bear no trace of the cutting of the eye and no other characteristic feature that might shed light on if they were intended as upper or lower stones. Hence, for the moment, little more can be said of this group.

Roughout contexts and overview of their fashioning

The sites with the different roughouts cited above can be divided into three distinct categories: sites linked to rivers or roads, urban sites and rural sites.

Roughouts in river and road contexts

The first category comprises sites such as *Le Port* on the Aveyron River where roughouts could have been loaded onto ships. It is downstream from the workings of La Marèze (Saint-Martin-Laguépie). This group also recalls the roughouts found at a loading zone at Agde (Aris 1986-1987: 15), as well as that of the shipwreck off the Island of Brescou facing Agde (Gallet-de-Santerre 1962: 622).

The sites of La Wantzenau and Bannay also fall into the fluvial transport group. They correspond respectively to a Roman shipwreck and to the cargo of either a medieval capsised vessel or to a load displaced by a flood. La Wantzenau is less than 20 km north-east of Strasbourg at the confluence of the Ill and the Rhine Rivers. Its stones are volcanic procured in quarries in the Eifel (Germany), specifically around Mayen. These workings, approximately 270 km north of Strasbourg, produced semi-finished products, mainly at Bellerberg, that were transported to workshops at the port city of Andernach, from where they were shipped elsewhere (Mangartz 2007).

The Bannay assemblage in the Loire River, dating probably from the Early Middle Ages, is also is a clear case of fluvial transport of unfinished millstones. Although their rock type has yet to be confirmed, their source is most likely among the nearby outcrops upstream. Only future petrographic analyses will offer a more precise view of their provenance.

Besides these two sites, there are six other Roman and medieval shipwrecks in the Mediterranean transporting millstone cargoes (Gallet-de-Santerre 1962; Sénac 2001). A load of Protohistoric or Roman roughouts was identified off the coast of the Island of Brescou (Gallet-de-Santerre 1962: 622) and a pair of Roman millstones were in a shipwreck in the Bay of Maguelone near Montpellier (Longepierre 2012: 220).

For the medieval period there are three millstones at the wreck of Rocher de l'Estéou off the coast of Marseille (Bouches-du-Rhône). Four more are at Roche Fouras off Ramatuelle (Var) dated to the 9th and 10th centuries. Twenty rhyolites from the Esterel are in the shipwreck of Jarres at Agay (Var) dating to the 10th century (Brun 2000). Finally, 19 millstones are in the wreck of Bataiguier, a 10th-century Arab-Muslim merchant ship that foundered in the Bay of Cannes (Alpes-Maritimes) (Joncheray 2007). It is noteworthy that the cargoes of Bataiguier and Agay were finished products with pierced eyes and cuttings to lodge driving mechanisms.

The group of rotary querns from Choisey in the French Jura beside the Roman road linking Besançon to Chalon-sur-Saône is likewise interpreted as a cargo. It is 10 km west of the Serre Massif known for its long tradition of producing querns and millstones (Jaccottey 2011). It is assumed that the Choisey group was part of a cargo of at least seven finished querns and two *catilli* roughouts reflecting surface transport to sites in the vicinity of the quarries where they were produced.

The sites of Saint-Martin-Laguépie and La Wantzenau evidence shipping by water in Roman times, a means adapted to heavy goods. La Wantzenau, moreover, is an example of long distance transport. The group from Choisey, on the other hand, is presumably a overland transport limited to a reduced sphere. Later medieval fluvial transport is evidenced by the assemblage of Bannay.

Hence, quern and millstone cargoes on shipwrecks in Antiquity, with the exception of that of the Bay of Maguelone, are practically exclusively semi-finished stones (cutting of the eyes hardly begun at La Wantzenau, roughly cut edges at Choisey, generalised absence of cuttings for driving fittings). This coincides with the findings of millstone quarry researuch indicating that unfinished products systematically left the Roman workings. The millstones associated with medieval shipwrecks in the Mediterranean, on the contrary, appear to be finished, ready-to-use products. This difference appears to follow chronological lines.

Roughouts in urban contexts

The second group corresponds to roughouts unearthed in Roman urban contexts. Autun (Saône-et-Loire) was a Roman centre founded under Augustus that succeeded the *oppidum* of Bibracte as the capital of the *Aedui* tribe. The excavations at "Faubourg d'Arroux", near Autun's North Gate ("Porte d'Arroux"), brought to light a quarter specialised in a numer of crafts including millstone fashioning. This is evidenced by finds of 19 roughouts hewn from local sandstone outcrops located in a circumference of about 20 km.

Several of these roughouts broke during the last phases of their manufacture and were reused as construction material. The reuse of these discarded pieces, as well as old, worn out millstones unearthed in other nearby features, explains the site's large number of fragments. The workshop, specialising in adjusting the grinding surfaces and their subsequent sale, is dated between 40 and 70 AD.

To this urban group can be added the site of Horbourg-Wihr, one of Alsace's three *vici* recorded in Roman epigraphy. It was founded *ex nihilo* in the 1st entury and gained importance in the next century. To date, two distinct quarters have been identified: a residential area to the north and an industrial quarter (potters, bronze workers, …) in the centre. Trial trenches in the industrial quarter (Nilles 2013) brought to light what appears to be another Roman millstone finishing workshop. The three roughout were hewn from quartzitic sandstone (*Bundsandstein*), a rock with outcrops at least 20 km away. This type of rock makes up 98% of the querns and millstones of the Haut-Rhin Department (Jodry 2011). A fourth, discovered a few dozen metres away, could form part of the lot.

The recent Roman finds of Autun and Horbourg-Wihr therefore highlight the existence of fashioning and finishing workshops in urban contexts. In each case, the quarries yielding the products were nearby and the stones arrived in a half-finished state. Moreover, the data gathered from the two urban sites concur with the findings of contemporary quarries and transport sites. Other urban finds include Lenzburg, Avenches and Lausanne in Switzerland, and Mazières-en-Mauge, Argentomagus, Agde and Lattes in France.

Roughouts in rural contexts

The excavations of the rural sites of Obernai and Ingenheim have identified unfinished querns. Obernai is a La Tène settlement about 30 km south-west of Strasbourg characterised by a moated enclosure surrounding numerous dwellings that contain both roughouts (sandstone and rhyolite) and chipping flakes. The nearest sandstone outcrops corresponding to the roughouts are two kilometres to the west and extend over a surface of about 40 km2 between the Bruche River and the Sainte-Odile Mountain in the Vosges. The sandstone roughouts are visually identical to that extracted at the workings of Purpurkopf-Rosheim, about 15 km to the west,

along the outcrop's western fringe. The rhyolite, on the other hand, is most likely an import from La Salle, about 80 km to the south-west, as there are few other nearby outcrops of this type of rock.

The Roman site of Ingenheim is equidistant (15 km) from the sandstone of Kronthal (Commune of Marlenheim) to the south and the sandstones that outcrop near Saverne (Commune d'Eckartswiller) to the west.

The context of the roughtouts of these two rural sites can be compared to that of Bussy/Prés de Fond (Fribourg, Switzerland) where a shell-rich sandstone roughout 40 cm in diameter was recovered in the backfill of a Roman well (Anderson *et al*. 2003, 54, fig. 59). Roman quern quarries of this type of shell-rich sandstone (Châbles and Chavannes-le-Chêne) are known a few kilometres from Bussy in the Haut Broye, a region stretching across the Cantons of Fribourg and Vaud.

Discussion

A first finding of this study is that Late Iron Age and Roman querns and millstones are not finished at their quarries. This is observed at the extraction sites of La Salle, Collonge-en-Charollais, Châbles, Obernai, Rosheim and Saint-Andeux. Furthermore, the products were transported in semi-finished form and the finishing their surfaces, adjustment of their grinding faces and cuttings for fittings took place elsewhere.

The technical aspects related to quern and millstone production, from the initial "quarry" phase of the operating sequence, follow different scenarios that do not appear to be exclusively linked to chronology but to the nature of the rock and its availability and workability. The mechanical features such as hardness, abrasiveness and coarseness are therefore not the only criteria to consider before extracting and commercialising the product (Fronteau and Boyer 2011: 114). Hence availability and workability are factors that must be taken into account as they will respectively play a role in the distance the product is shipped and if there is an initial phase of pre-fashioning.

The roughouts identified in quarry contexts in this study, whether from the Late Iron Age (La Salle, Rosheim or Saint Andeux) or Roman Era (Châbles, Collonge-en-Charollais, La Salle or St. Andeux), and whether of sandstone, rhyolite or vaugnerite, offer signs of following the criteria of availability and workability regardless of their chronology.

While sandstones are common sedimentary rocks that are readily available and relatively easy to carve, rhyolites and vaugnerites, magmatic rocks, are more arduous to fashion, restricted to specific outcrops and shipped much greater distances. These two rocks are therefore exceptional among the grinding stone quarry landscape.

Despite their differences, analogous operational sequences can be established between the detached block sandstone workings of Collonge-en-Charollais (Jaccottey *et al.* 2011), the rhyolite workings at La Salle (Farget 2006; Farget and Fronteau 2011) and the vaugnerite productions at Saint Andeux (Jaccottey *et al.* this volume).

In sum, the similarity of the characteristics of these roughouts leads us to give credence to the existence of a standard pattern of quern and millstone production. The roughout, whether of sandstone, rhyolite or vaugnerite, is a semi-finished product when shipped. Certain sandstone roughouts, nonetheless, were worked differently. This is particularly the case of the roughouts from Purpurkopf-Rosheim in the Alsace that appear to be less complete as no case reveals the carving of the grinding surface or the cutting of the eye. Yet this difference can possibly be explained by this site's modest quantity of roughouts (5), far below that of other sites (272 roughouts at Châbles, 102 at Saint-Andeux, 63 at La Salle, 27 at Collonge-en-Charollais), a number too modest to observe all the different phases of production.

The collection of data evidencing roughout fashioning in workshops points to a procedure that is almost identical to that of the assemblages found beyond quarries. Following this schema, the case of the rural Late Iron Age site of Obernai is extremely compelling as it reveals two different procedures of manufacture depending on the type of rock. While local sandstone products (with outcrops as near as 2 kilometres) took on the form of roughly chipped cylinders that were finished in a workshop (as evidenced by the sandstone flakes), the rhyolite handmill arrived in a nearly finished form, missing only its grinding surface and its central and lateral cuttings.

The state of work of these roughouts recalls that of Saint-Quentin-la-Poterie where sandstone quarries from Late Antiquity were divided into four concessions and where four Roman settlements in the plain below the quarries have both roughouts and zones of chipping flake (Longepierre 2009).

The distance between the quarries and the settlements with the workshops in Roman times appears to range between 500 m and 2 km. Some of the fashioning at urban Collonge-en-Charollais took place only a few hundred metres from the quarry (Longepierre 2009). The same is observed at Mayen in the Eifel (Germany) where querns were not completed at the quarry but in the neighbouring *vicus* (Mangartz 2007). According to this schema, the settlement of Obernai could contain a quern workshop directly linked to a quarry as in the case of Collonge-en-Charollais or Saint-Quentin-la-Poterie. Obernai's rhyolite handmill pair, however, is a long distance import (about 60 km) in a half-finished form (rough carving of the grinding surface and partial cutting of the eye and handle socket). The Obernai workshop is therefore characterised by two models of production, a first to finish local stone roughouts and a second to finish exogenous querns.

This model is evidenced by the cargoes of Choisey and La Wantzenau dated to the end of the Late Empire. These examples of fluvial transport bear grinding surfaces in the process of carving and traces of pre-cuttings that minimise the risk

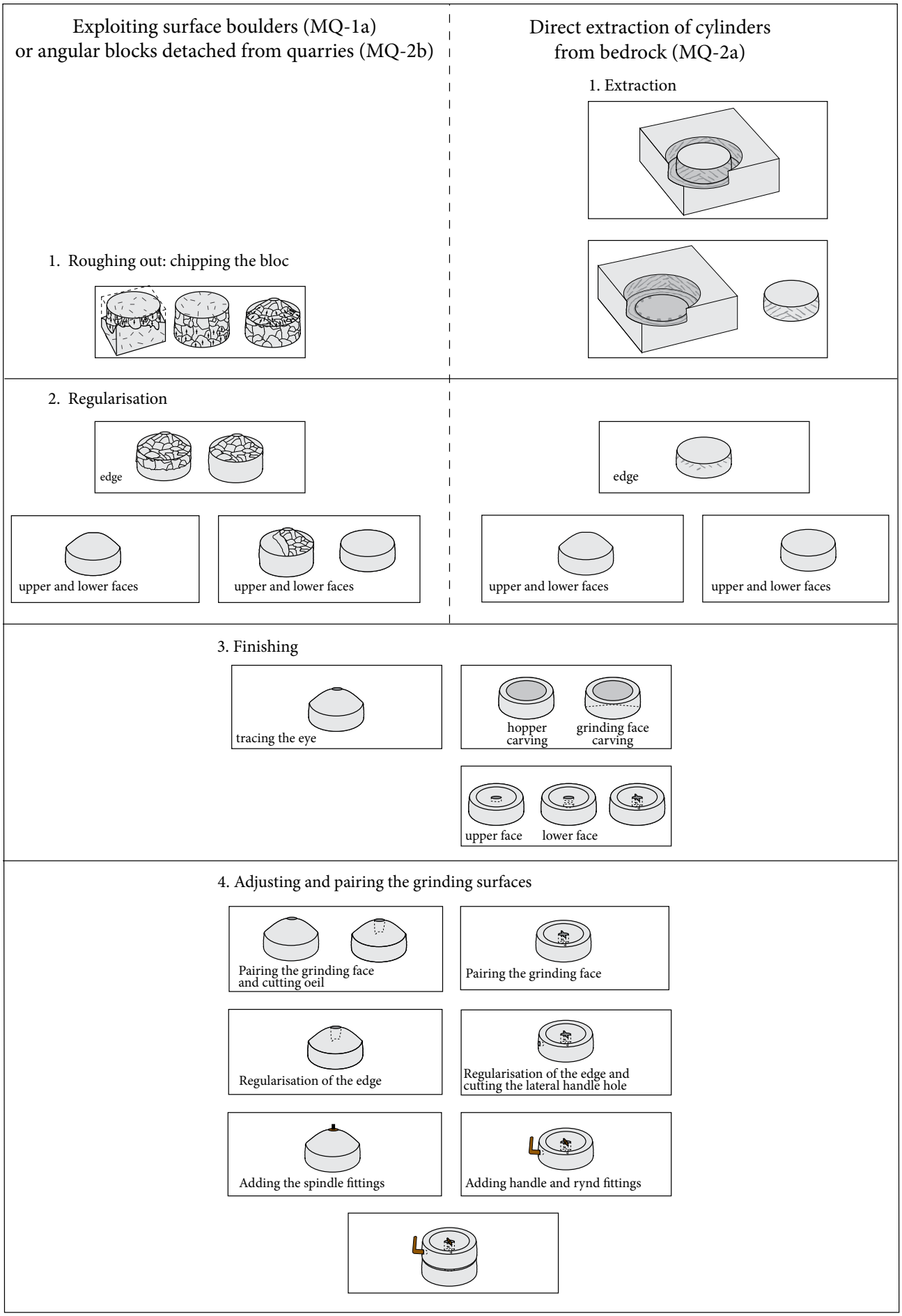

Fig. 14: Operational sequence of the manufacture of rotary querns according to the different types of extraction (Anderson 2014; 2016) through the subsequent phases of finishing and adjusting (L. Jaccottey, INRAP).

of fracture during the final piercing of the eye at the workshop.

This study therefore identifies a segmentation of the operational sequence of quern and millstone manufacture of blocks (Fig. 14) obtained either in the form of boulders collected on the surface (MQ-1a) or quarries yielding angular blocks detached from their faces (MQ-2b), from cylinders directly hewn from bedrock in true extractive quarries (MQ-2a) (Anderson 2014; 2016). In this last case the roughouts underwent a first phase of fashioning in workshops near the quarry followed by transport in the form of semi-finished products to specialised sites where they were finished before seeing service. This implies the presence of specialists in the quarries and their workshops, as well as in the workshops where they were finished, a model of production that is in place at the end of the Iron Age and throughout Roman times.

Millstones cargoes in medieval shipwrecks in the Mediterranean, on the contrary, point to a different model of production. The Agay and Bataiguier cargoes differ from the model advanced for the two earlier chronological periods as they are finished products. It appears that the transition from the Roman Era to the Middle Ages marks a change in the pattern. A future study of the assemblage of millstones at Bannay, still under the waters of the Loire River, would certainly offer new data to assess this question.

Abbreviations

AFAN: Association pour les fouilles archéologiques nationales
DRASM: Département des recherches archéologiques subaquatiques et sous-marines
INRAP: Institut national de recherches archéologiques préventives

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